ENVIRONMENTAL PROTECTION AGENCY WEATHER PROGRAMS

The Environmental Protection Agency (EPA) is responsible for working with state, local, and other federal government agencies to provide user-appropriate and scientifically credible air quality meteorological programs to support regulatory applications. Applied research and meteorological support are furnished primarily by the EPA National Exposure Research Laboratory and the EPA Office of Air Quality Planning and Standards, both located in Research Triangle Park, North Carolina. This activity is provided through interagency agreements with the National Oceanic and Atmospheric Administration (NOAA), which provides approximately 50 research meteorologists to the EPA.

Meteorological support to the EPA Office of Research and Development, the EPA Office of Air and Radiation, the EPA Regional Offices, and to state and local agencies includes: (1) development and application of air quality dispersion models for pollution control, direct and indirect exposure assessments, and strategy creation; (2) preparation and performance of dispersion studies and air quality model evaluations; and (3) review of meteorological aspects of environmental impact statements, state implementation plans, and variance requests. Meteorological expertise and guidance are also provided for the air quality standard, modeling guideline, and policy development activities of the EPA.

In light of the 1990 Amendments to the Clean Air Act, air quality models and the manner in which they are used are expected to evolve considerably over the next few years. In the area of pollutant deposition, the evaluation of nitrogen, oxidant, sulfur and aerosol chemistries will clarify the roles of model formulation, cloud processes, radiative transfer, and air/surface exchanges in air quality model predictions, leading to a better understanding of model predictions relative to control strategy assessments. Further development and evaluation of existing air quality models will take place to accommodate the inter-pollutant effects resulting from the variety of control programs that are now or may be in place, such as the recent revisions to the National Ambient Air Quality Standards for ozone and particulate pollution. These inter-pollutant effects include trade-offs among controls on ozone, sulfur oxides, nitrogen oxides, and volatile organic compounds, as well as developing predictable methods of forecasting the impacts on various measures of air quality.

With respect to inhalable particulate model development, dispersion models are being enhanced to accurately predict aerosol growth from precursors over local and regional transport distances. To assist in the evaluation of the contribution of various sources to regional air degradation, inert tracer and tagged species numerical models have been developed. These models will introduce separate calculations for inert or reactive chemical species emitted from a particular source or region. The calculations will proceed to simulate transport and transformation to a receptor point, where the contribution of the particular source could be isolated.

With respect to oxidant air quality modeling, the roles of biogenic volatile organic compounds, rural nitrogen oxides, and vertical transport will be elucidated. A better understanding will be developed of the fundamental aspects of the ozone nonattainment problem such as differences in urban and rural rates of and/or sources of photochemical production and the interaction through transport of these ozone precursors. Much of this research will be performed under the program previously known as the North American Research Strategy on Tropospheric Ozone, but now known as NARSTO.

Atmospheric research in the areas of climate and climate change includes ozone distribution in the global troposphere, the relationship between that ozone distribution and climate (including temporal and spatial aspects), and regional climate studies addressing the interaction of climate with the biosphere. The climatology program involves both analytical and statistical climatology as well as support for regional-scale climate model development. Climate change issues and their feedbacks with the biosphere are being stressed.

Research in human exposure modeling includes microenvironmental monitoring and modeling, and development of exposure assessment tools. Microenvironmental algorithms are being developed based on field data to predict air quality in buildings, attached garages, and street canyons. These improved algorithms are then incorporated into microenvironmental simulation models for conducting human exposure assessments within enclosed spaces in which specific human activities occur.

In addition to these major areas, dispersion models for inert, reactive and toxic pollutants are under development and evaluation on all temporal and spatial scales, e.g., indoor, urban, complex terrain, mesoscale, and regional. Other efforts include construction and application of air pollution climatologies; modeling of agricultural pesticide spray drift and of fugitive particles from surface coal mines; modeling of trace metal deposition to the Great

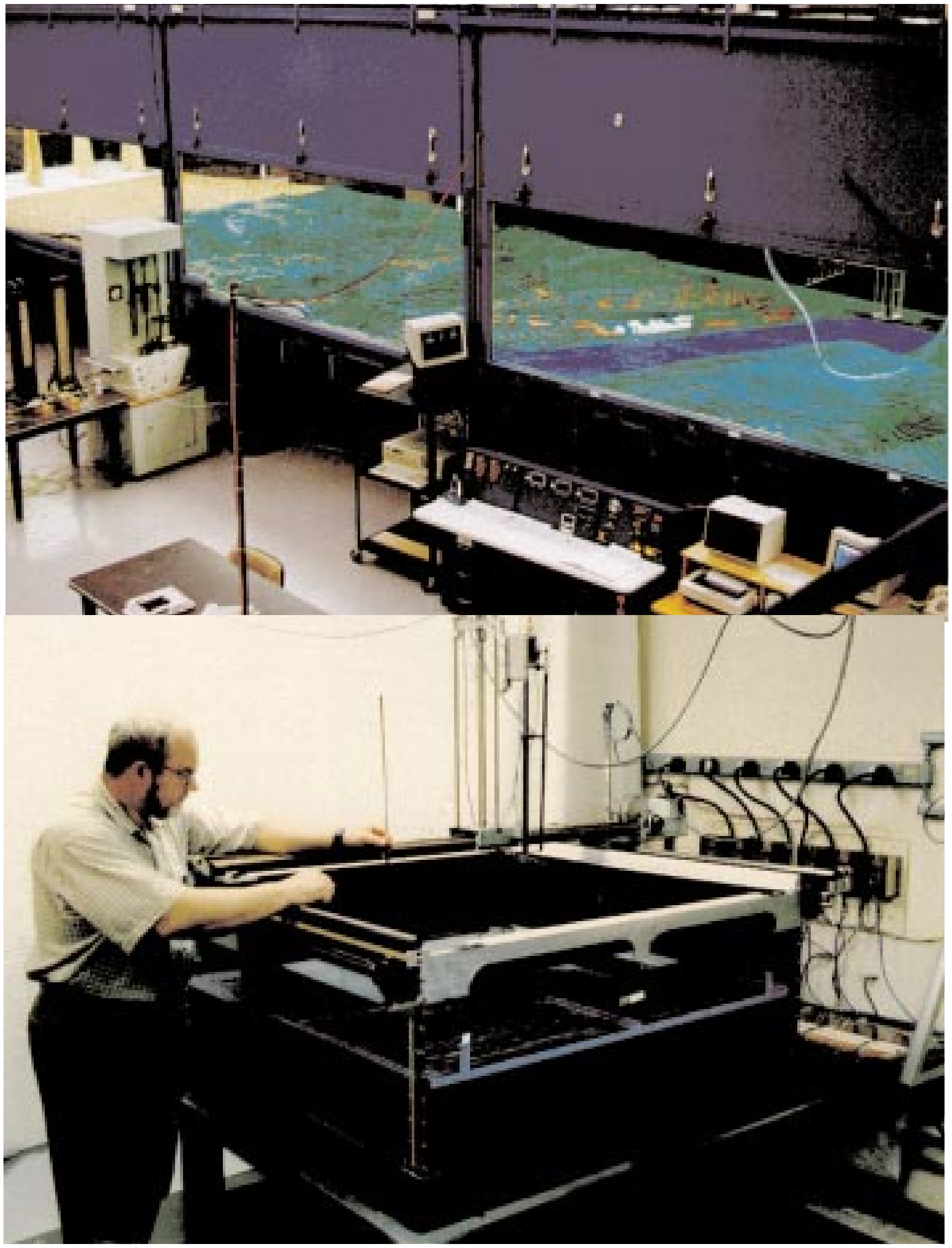

Figure 3-EPA-1. The EPA Fluid Modeling Facility conducts laboratory simulations of atmospheric flow and dispersion using a meteorological wind tunnel (top) and a convection tank.

Lakes, nutrient deposition to Chesapeake Bay, and mercury deposition to the Florida Everglades; modeling of accidental releases of toxic compounds forming dense gas clouds; determination and description of pollutant effects on atmospheric parameters; and conversely, determination of meteorological effects on air quality. Atmospheric flow and dispersion experimental data obtained from wind tunnel, water channel/towing tank, and convection tank experiments in the EPA Fluid Modeling Facility (Figure 3-EPA-1) will be used to continue development and evaluation of these models in the FY 2001-2002 period, along with providing researchers with insight into the basic physical processes that affect pollutant dispersion around natural and man-made obstacles. The convection tank will be used to simulate and develop improved models for open burning and open detonation of surplus and obsolete military munitions (Figure 3-EPA-2).

EPA participation in the interagency High Performance Computing and Communications (HPCC) Program is enabling increased efficiency in air quality meteorological modeling through research on parallel implementation of the Mesoscale Meteorological Model (MM5), with the subsequent transfer of these achieved efficiencies to the user community. The HPCC Program contributed to development of the Models-3/Community Multi-scale Air Quality (CMAQ) modeling system, a flexible environmental modeling and decision support tool to deal with multiple scales (urban to regional) and multiple pollutants simultaneously, thus facilitating a more comprehensive and cost effective "one atmosphere" approach to related single-stressor and multi-stressor human and ecosystem problems. Models-3 provides a framework to support the constant evolution of environmental models to handle more complex issues such as fine particulates, visibility, toxic pollutants, and multi-media (air and water) environmental assessments in an integrated manner.

Over the past twenty-five years, numerous air quality simulation models have been developed to estimate reductions of ambient air pollutants resulting from potential emission control strategies. Separate models were developed, for example, for tropospheric ozone and photochemical smog, for acid deposition, and for fine particles. Distinct models also existed for addressing urban scale problems and the larger regional scale problems. It has been recognized, however, that the various pollutant regimes are closely linked chemically and spatially in the atmosphere. The principal purpose of the Models-3/CMAQ project was to develop a "one atmosphere" model that integrates the major atmospheric pollution regimes in a multi-scale, multi-pollutant modeling system, with high-level computational access by both scientific and air quality management users for socio-economic applications in community health assessments and ecosystem sustainability studies.

After seven years of development, Models-3/CMAQ was released in June 1998 and is being updated annually for use by Federal agencies, States, industry, and academia. It is also intended to serve as a community framework for continual advancement and use of environmental assessment tools. Models-3/CMAQ is available on 8mm Exabyte tapes accompanied by an Installation and Operations Manual, a User Manual, a Science Document, and a Tutorial providing step by step instructions for use of the modeling capabilities. For more information, visit the Models-3 web site at *http://www.epa.gov/asmdnerl/models3/*

The evolving Multimedia Integrated Modeling System (MIMS) research seeks to improve the environmental management community's ability to evaluate the impact of air quality and watershed management practices, at multiple scales, on stream and estuarine conditions. Toward this goal the primary objectives are to (1) develop a prototype multiscale integrated modeling system with predictive meteorological capability for transport and fate of nutrients and chemical stressors; (2) enable the use of remotely sensed and monitored meteorological and air quality data, and process-based parameter estimation techniques in multiscale ecosystem assessment models; and (3) develop an easy to use computer-based problem solving environment with ready access to data, models, and integrated visualization and analysis tools for use in exposure-risk assessments, ecosystem restoration design, and policy development and refinement from regional to local scales. The MIMS development extends the open architecture approach demonstrated in the third generation modeling system, Models-3/CMAQ, to provide a framework for selecting meteorological, chemical, physical, and biological process components to build customized models for specific problems/domains, and to facilitate interaction among media specific models.

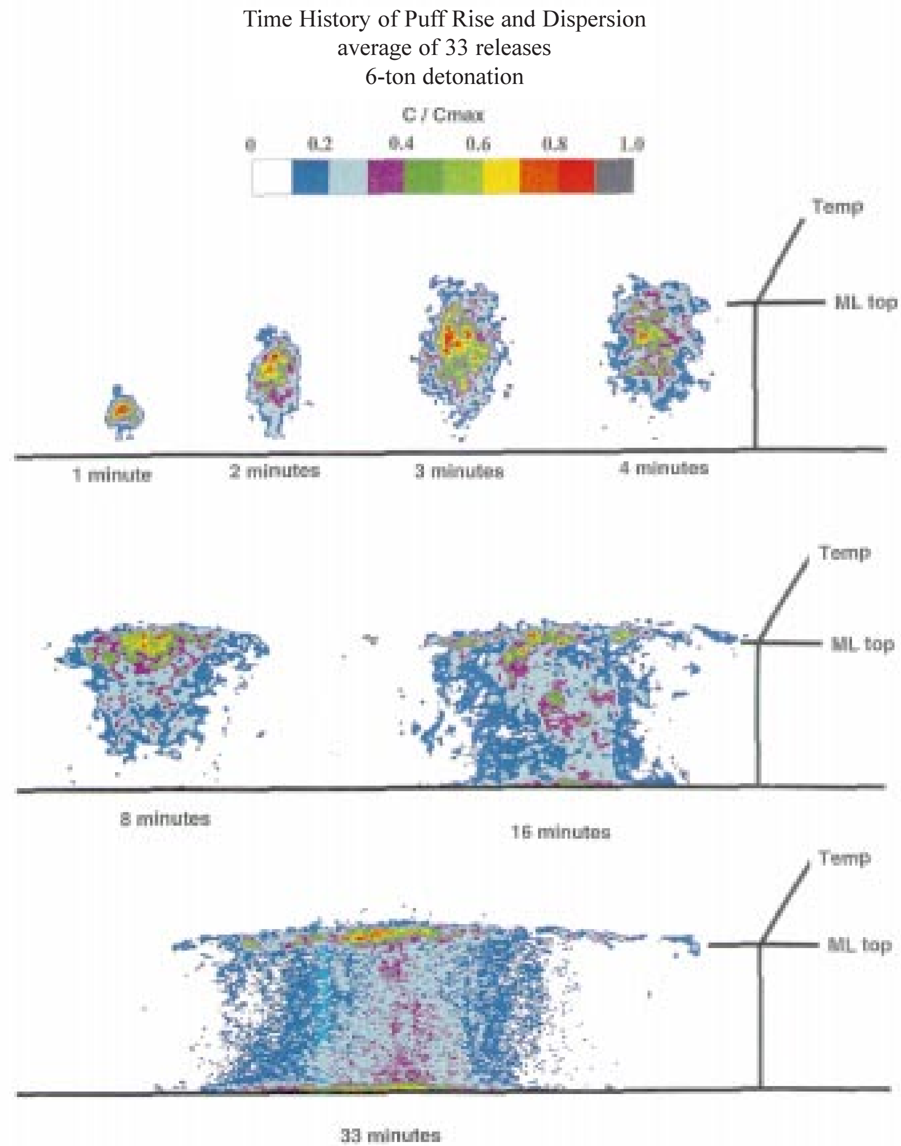

Figure 3-EPA-2. This series of photographs from a convection tank experiment shows the rise of a bouyant puff in a convection boundary layer capped by an inversion. These laboratory simulations were used to develop improved models for predicting the transport and fate of pollutants released during the open burning and open detonation of obsolete munitions.

The EPA also maintains relations with foreign countries to promote exchange of research meteorologists and research results pertaining to meteorological aspects of air pollution. One of the most active areas of cooperative research is with Russia under the 1972 Nixon-Podgorny Agreement forming the US/USSR Joint Committee on Cooperation in the Field of Environmental Protection and under the 1993 Gore-Chernomyrdin Agreement forming the US/Russia Commission on Economic and Technological Cooperation. Other agreements are in place with Canada, Japan, China, and Mexico, and with several European countries under the NATO Committee on Challenges of Modern Society (CCMS).